Global Environmental Change 34 (2015) 59–69

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Public values for energy system change

Christina Demski[a,*], Catherine Butler[b], Karen A. Parkhill[c], Alexa Spence[d], Nick F. Pidgeon[a]

[a] Understanding Risk Research Group, Tyndall Centre and Climate Change Consortium of Wales, School of Psychology, Cardiff University, Cardiff CF10 3AT, UK
[b] Department of Geography, College of Life and Environmental Sciences, University of Exeter, Exeter EX4 4RJ, UK
[c] Environment Department, University of York, York YO10 5DD, UK
[d] Horizon Digital Economy Research/School of Psychology, University of Nottingham, Nottingham NG7 2TU, UK

ARTICLE INFO

Article history:
Received 9 September 2014
Received in revised form 9 June 2015
Accepted 11 June 2015
Available online xxx

Keywords:
Public acceptability
Public perception
Energy system transitions

ABSTRACT

In this paper we discuss the importance of framing the question of public acceptance of sustainable energy transitions in terms of values and a 'whole-system' lens. This assertion is based on findings arising from a major research project examining public values, attitudes and acceptability with regards to whole energy system change using a mixed-method (six deliberative workshops, $n = 68$, and a nationally representative survey, $n = 2441$), interdisciplinary approach. Through the research we identify a *set of social values* associated with desirable energy futures in the UK, where the values represent identifiable cultural resources people draw on to guide their preference formation about particular aspects of energy system change. As such, we characterise public perspectives as being underpinned by six value clusters relating to efficiency and wastefulness, environment and nature, security and stability, social justice and fairness, autonomy and power, and processes and change. We argue that this 'value system' provides a basis for understanding core reasons for public acceptance or rejection of different energy system aspects and processes. We conclude that a focus on values that underpin more specific preferences for energy system change brings insights that could provide a basis for improved dialogue, more robust decision-making, and for anticipating likely points of conflict in energy transitions.

1. Introduction

It is widely accepted that transformations in energy systems will be essential in realising low carbon energy transitions (DECC, 2011; IEA, 2013; Bulkeley et al., 2013). Publics are deeply implicated in energy transitions, for example as consumers and producers of energy, as citizens with voting powers, or as active protesters and proponents of energy infrastructures. As such, public acceptability is recognised to be of critical importance in processes of energy system transformation, with the potential to present both opportunities and challenges for the delivery of energy policy. Public perspectives are, however, often not included in future energy scenarios. Where public views are depicted they tend to emerge as 'imagined publics' with little grounding in empirical analysis (Walker et al., 2010; Spence and Pidgeon, 2009). In this paper, we present the results of an in-depth empirical study of public attitudes and acceptability with regards to energy transitions, delineating a set of public values for energy system change.

The research and analysis undertaken for this paper is based on two assertions regarding the conceptualisation of public acceptability. First, we argue the need to go beyond examining public attitudes toward individual system elements (e.g. nuclear energy), and look instead at how they manifest in relation to interconnected processes of *whole energy system change*. This enables us to establish a more complex picture of public views by identifying contingency and the relevance of trade-offs (e.g. between higher costs and renewable energy) for public acceptability.

To elaborate, previous research on public attitudes, acceptability and engagement with issues relevant to energy system change has largely focused on single elements of change, e.g. carbon capture and storage (CCS) or electric vehicles (see Whitmarsh et al., 2011). There is a surprising paucity of research examining public perspectives on the combined set of transformations that are envisaged in policy, academic, third sector and industry scenarios (e.g. DECC, 2010; WWF, 2011; Ekins et al., 2013; National Grid, 2014). Energy systems involve a complex array of supply and demand technologies, resources, infrastructures, behaviours and practices, as well as other elements associated with regulation, policies, actors and institutions. Public acceptability will likely be dependent upon the way transformations occur as a whole because

* Corresponding author. Tel.: +44 29 2087 6020; fax: +44 29 2087 4858.
E-mail address: DemskiCC@cardiff.ac.uk (C. Demski).

http://dx.doi.org/10.1016/j.gloenvcha.2015.06.014

people's judgements of particular elements (e.g. a technology) have been shown to depend on other aspects being realised (e.g. the associated governance arrangements; see Wynne, 1996).

Recent research has begun to explore public perceptions beyond individual aspects of change, for example by eliciting views about portfolios of energy supply technologies (De Best-Waldhober et al., 2009; Fleishman et al., 2010; Einseidel et al., 2013). This work has, for example, shown strong preferences for some energy technologies (e.g. renewables) over others (e.g. CCS; Scheer et al., 2013). However, we further argue that research in this field must be attuned to the inherent complexities and issues of scale that publics have to contend with when taking a broader view of the energy system and its inherent interdependencies (Pidgeon et al., 2014). To do this we take a 'whole-system view' considering public perspectives on the combined set of supply and demand transformations envisioned in UK national energy policy scenarios.

Second, we assert the need to consider public perspectives not only in terms of attitudes and acceptability but also in terms of the *values* and the more general concerns that underlie positive or negative views of any particular technology or process. Much research focuses on basic preferences – positive or negative evaluations of something – with only limited research going beyond these basic conceptualisations of public acceptability (e.g. Curran, 2012). This approach does not account for the often highly conditional nature of public views, such as the reluctant acceptance of nuclear power when placed in the context of climate change (Bickerstaff et al., 2008). As such, conditionality (e.g. on particular policy, geographic, or social contexts) is an important consideration when examining public perspectives.

The argument to consider values and more general concerns that underlie specific responses or attitudes is further premised on established research on public engagement with complex socio-technical and risk issues (e.g. see Pidgeon et al., 1992; Wynne, 1992; Jasanoff and Wynne, 1998; Macnaghten, 2010). Building from this body of work, we argue that because energy system change encompasses highly complex sets of transformations, framed at varied geographical and temporal scales, they contain multiple elements that will be both unfamiliar to people, and inherently uncertain. Under such circumstances people are unlikely to have fully formed views, and a need therefore arises to engage with the processes through which beliefs become constituted (Macnaghten, 2010).

Although people might not come to engagement processes with fully formed views, neither are responses constructed in a vacuum (Lichtenstein and Slovic, 2006). Public perspectives regarding complex socio-technical issues are formed through a process of interpreting new information with existing values, experiences, worldviews and socio-cultural understandings about the world (e.g. see Moscovici, 1984; Jasanoff and Wynne, 1998; Miller, 2000 Miller, 2000). Therefore we argue it is important to examine what underpins expressed attitudes and preferences, and that this kind of analysis might bring more meaningful theoretical and empirical insights into public perspectives. Such insights can, in turn, form a basis for improved dialogue, more robust decision-making, and for anticipating likely points of conflict in transition processes (Butler and Demski, 2013).

We explicate this argument through the remainder of the paper beginning with a brief discussion of the conceptual literature on values. We then present a detailed discussion of our methods and analytic approach before outlining a set of values that broadly underlie public attitudes toward energy system change. Here, illustrative examples from the data are provided to complement a narrative account of the values. We conclude by reflecting on the significance of the insights derived from the research for understanding public acceptability with regards to energy system change.

2. Conceptual background

While the term 'values' is used in a multitude of domains (politics, media, economics), it is important to note that the way it is used within the social sciences is often more focused. In basic terms, values refer to beliefs about how the world should be, and capture personal and cultural principles about states of existence and modes of conduct; they are ideals about what ought to happen regardless of situational context (e.g. Fischhoff, 1993; Chan et al., 2012). Varied disciplines within the social sciences differ, however, in their precise definitions and meanings of values; e.g. from cognitively held beliefs to cultural principles embedded in social structures (e.g. Reser and Bentrupperbäumer, 2005; Douglas, 1992; Hards, 2011). Nonetheless, most stress the importance of understanding values in the context of addressing wider societal issues. For example, from a human geography perspective, Adger et al. (2013) emphasise the importance of understanding cultural values in climate change responses to ensure policies effectively connect with what matters to communities. In psychological literatures, the importance of incorporating values in science communication to facilitate public deliberation and explore points of contestation has been highlighted (Dietz, 2013). Others have argued for the need to focus on shared social psychological and environmental values, rather than individualistic preferences in order to engage people with sustainability (Crompton, 2011; Corner et al., 2014).

Much of the psychological literature has focused on defining universal human values, theorised to reside as cognitive representations within individuals (e.g. Hitlin and Piliavin, 2004; Maio, 2010). By contrast socio-cultural approaches move the emphasis away from individual cognition to denote values as salient cultural resources (Douglas and Wildavsky, 1982; Wynne, 1996; Jasanoff and Kim, 2013). From this perspective values do not reside within individuals but have a public character; they are socially constituted and derived from interactions in the world. Further, values are not theorised as drivers or causal determinates of social action, but as ideals that require people to engage pragmatically with material and social arrangements that are not consistent with them. Central to this is the significance of scale and the ways that people constantly need to change the scope of their engagement, shifting between modes that are engaged in local or individual circumstances and those oriented towards the general or the 'public' (Thevenot, 2001; Butler et al., 2013).

We align here with this latter conceptualisation of values, by adopting the societal level as our principal unit of analysis (Hechter, 1993). Accordingly, we present a *shared set of social values* that pertain specifically to energy system change and invoke a mode of engagement that is oriented toward the general or the 'public', rather than the specific or personal. This is, in part, because the analysis in this paper aims to provide insight into what shapes acceptability of energy pathways *at a societal level*, building understanding of the culturally embedded ideals and general concerns that underlie specific preferences. The idea of a shared set of values, or a value *system* has precedence in other research and conceptual work (e.g. Brown, 1984).

In this research we draw on conceptions where the value set represents *prevalent identifiable cultural resources* or *collectively imagined forms of the social good* through which people anchor their understandings and formulate their preferences (Douglas and Wildavsky, 1982; Jasanoff and Kim, 2013). As such, the kinds of values we draw out of our own work with publics might be better conceptualised as expressions of ideals circulating within society as cultural discourses (Hards, 2011). In line with this, we do not assume that the identified value clusters are ordered in a specific way (unlike for example Schwarz, 1992), but do acknowledge that individuals have to engage pragmatically with values in a given

context (e.g. depending on salience) and that these engagements shift and change over time and scale. That said, precisely because they are culturally held shared conceptions of how the world *should* be, they are more deeply entrenched and less malleable than might otherwise be expected. In this sense, though they are not determinative, the values we set out give important insights into what helps shape social responses to energy systems.

The current analysis of public values for energy system change is therefore aimed at better understanding, not necessarily of individual acceptance or rejection of whole transition pathways, but rather of the kinds of concerns citizens bring to bear on a decision-making process regarding potential energy pathways. The identified value system connects to and facilitates the presentation of a broader vision for energy system change. In this sense, the values identified in this research might be thought of as a set of socially determined criteria that can be used as the basis for considering social dimensions within decision-making about energy transition processes.

3. Methods

The analysis in this paper brings together findings from a major programme of interdisciplinary research examining public values with regards to energy system change in the UK (Pidgeon et al., 2014). The empirical basis of the analysis comes from two interlinked research phases, namely six in-depth public deliberative workshops ($n = 68$), and a nationally GB representative online survey ($n = 2441$).

3.1. Sampling

Each deliberative workshop was held over a full day with 11–12 participants. The aim was to attain as diverse a set of societal perspectives as possible so that any emergent themes could be regarded as indicative of public concerns across a broad cross-section of people (Jasanoff, 2003). This sampling technique builds from the theoretical proposition that differential characteristics (such as age, where you live) will be linked to different kinds of life experience. In turn, different forms of life experience are expected to result in the emergence of varying perspectives (Strauss and Corbin, 1990).

Therefore, participants were sampled to ensure a mix of gender, age, ethnicity, socio-economic grouping, household type, and educational qualifications. Additionally, workshops were undertaken in different rural and urban locations across the UK to ensure diversity in experiences specifically related to energy (e.g. different types of housing, transport infrastructure, proximity to generating facilities), as well as across governance and cultural contexts (England, Wales and Scotland). London, Cardiff and Edinburgh were selected as three major UK cities and three more rural sites, Cumbria, Merthyr Tydfil and areas south of Glasgow, were selected for their proximity to energy infrastructures (nuclear, coal, and wind respectively). With these parameters, recruitment was undertaken by a professional company.

For the quantitative phase, the authors developed a survey instrument in conjunction with the social research company Ipsos MORI, which collected data using an online questionnaire between 2nd and 12th August 2012. A nationally representative quota sample of British adults (England, Scotland and Wales) aged 18 years and older was recruited to reflect gender, geographic region, age, and employment status using data from the Labour Force Survey 2006 (UK Data Service, 2006). Response rates are not indicative when using online quota-sampling as non-response cannot be easily defined (Dillman, 2007). Nonetheless, the drop-out rate (22%) was in line with other surveys of this kind and evenly distributed across all sections of the survey. Data obtained were broadly representative of characteristics sampled and then weighted to be representative of these same characteristics for further analysis.

3.2. Design

The two research strands elicited public views on the interconnected nature of energy system change at multiple scales, including different supply technologies, patterns of demand and behaviour, and governance and regulatory structures. Both research phases were carefully designed with input from a wider multidisciplinary team of academics, stakeholder interviews, an advisory panel, and existing literature. Fig. 1 broadly describes the survey and workshop design, but further details are given in two respective reports (see Butler et al., 2013; Demski et al., 2013 for Supplementary material).

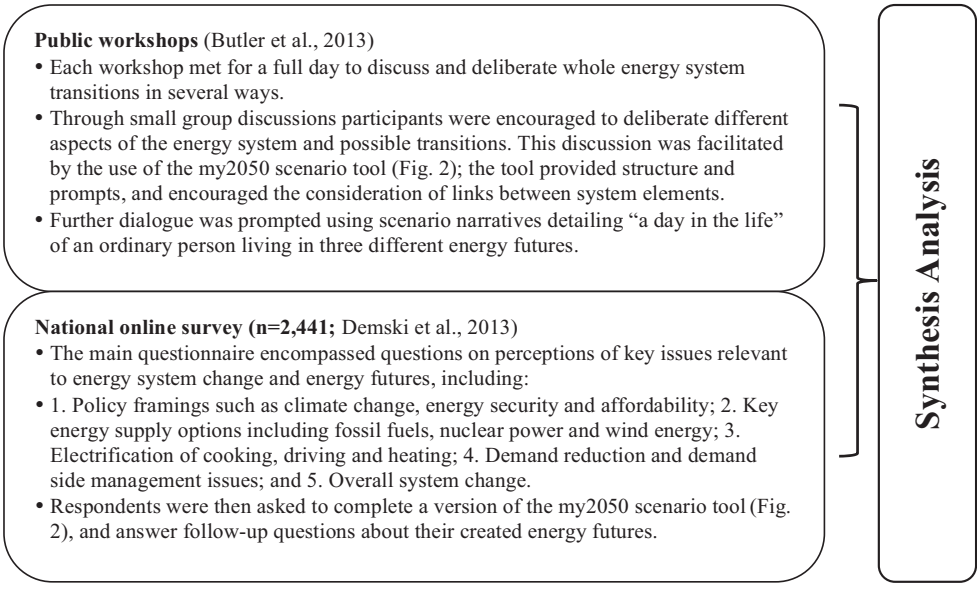

Fig. 1. Key procedural information for the two empirical research phases later combined in the synthesis analysis.

It is a formidable challenge to engage people with the complex interconnected nature of energy transitions (for detailed discussion see Pidgeon et al., 2014). Two issues are especially relevant for the analysis in this paper; (1) the ways in which 'the whole system' was kept in view when eliciting public perspectives; and (2) how we were able to access the deeper concerns that underlie people's preferences.

3.2.1. The deliberative workshops

Reflecting well established lines of argument in public participatory research, the deliberative workshops were designed to engage members of the public as active, imaginative agents, eliciting their insights relating to energy system change (Jasanoff 2003; Fischer, 1999). Three key modes of engagement were used. First, an open phase of whole group discussion involved participants reflecting on the major policy issues underlying reasons for change (e.g. climate change, energy security) and on the idea of the whole energy system (a concept that was unfamiliar to many). Second, in-depth discussions about energy system change were structured around the completion of the my2050 scenario tool (Fig. 2) which served to provide a whole systems perspective. This tool was utilised as a backdrop for more open discussion and we were careful to prompt on issues that were not included (e.g. air travel).

Third, we presented three energy system scenario narratives[1] detailing "a day in the life" of an ordinary person living in different energy futures. Participants were encouraged to reflect further on their expressed preferences for energy system change and consider the implications for everyday life. These three modes of engagement enabled participants to consider their views within the context of the whole energy system. As facilitators we prompted these reflections, for example, highlighting possibilities for higher costs associated with particularly desirable system configurations, such as high renewable scenarios. The resulting discussions were transcribed verbatim, anonymised and checked by a third party for accuracy.

3.2.2. The national survey

Although it is difficult to conduct a survey that keeps the whole system in mind, and accesses values, the survey was also specifically designed to achieve this. First, questions were constructed to examine basic preferences and acceptability as well as conditionality, attached concerns, and the contexts in which preferences might differ. This allowed inferences to be drawn about public acceptability beyond simple support for and opposition toward proposed changes (for similar approaches see De Best-Waldhober et al., 2009). Primarily we developed our understanding through examining patterns of responses to different questions, and to see if key features prompted significant changes in responses.

Second, the survey also included the my2050 tool (Fig. 2) which provided respondents with an opportunity to translate their preferences for individual elements of change into the context of creating a whole system scenario. For us as researchers this provided another point at which people would express preferences that could be compared to previous answers. Finally, insights were additionally derived by using open-ended questions about the reasoning underlying preferences. This provided a large dataset of qualitative responses that were analysed for emerging patterns, underlying concerns and consistency with the workshop discussions.

3.3. Analysis and synthesis

3.3.1. Combining data sets

Collecting multiple datasets using multiple methods was a deliberate design choice and it was important to include an analytic phase which explicitly brought the different research strands together to understand their combined insight. The qualitative and quantitative elements offered different qualities that were important to the synthesis analysis. For example, the survey was able to provide a certain weight to particular findings due to its large nationally representative sample (e.g. the strong preference to reduce fossil fuels), whereas the flexibility of the

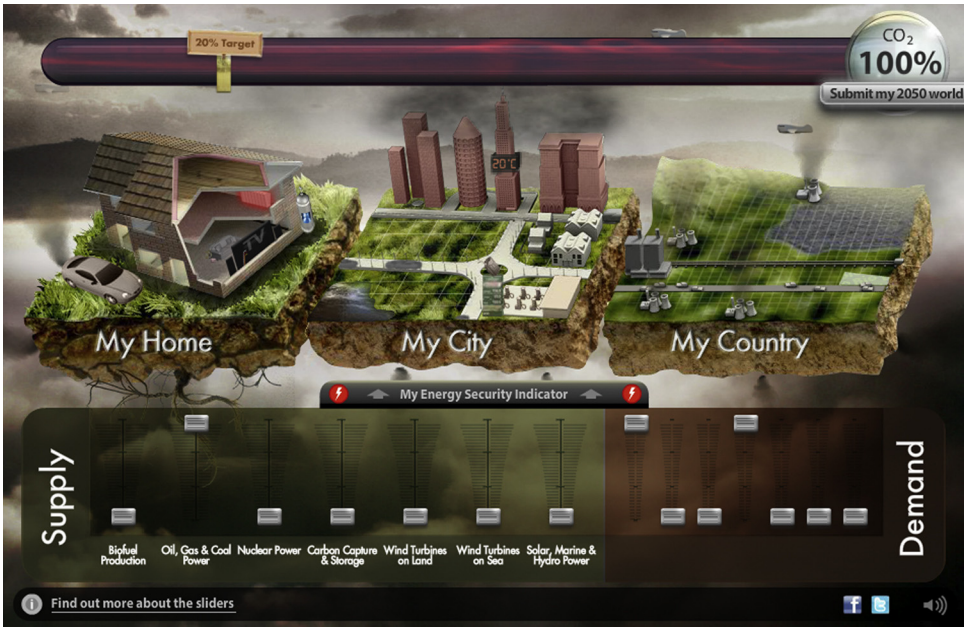

Fig. 2. The my2050 scenario tool illustrating the seven supply-side sliders. The tool is a simplified representation of the UK energy system. It enables exploration of different supply and demand-side options (including nuclear energy, fossil fuel generation, renewables, demand reduction, low carbon transport and heating systems, lifestyle changes) in order to reduce the UK's carbon emissions by 80% compared to 1990. It was initially developed by the digital democracy company Delib for the UK Department of Energy and Climate Change and Sciencewise-ERC. A version of this tool can be found here: www.my2050.decc.gov.uk. (Contains public sector information licensed under the United Kingdom's Open Government License v2.0).

deliberative workshops allowed for additional or new discussions to emerge (e.g. the importance of distrust in energy companies) and offered greater means for probing what underpinned preferences. In this way the synthesized findings could be sufficiently deliberative but also stand to reflect wider, nationally held public views.

Although the design and delivery of both research phases was important in enabling our understanding of values, the *analytic process* itself was central to developing insight into the concerns underlying expressed preferences of whole energy system change. The analytic process considered the data as a whole and examined different data streams in light of each other. In this way, the findings and interpretations that arose from one set of data were both complemented and challenged by those arising from the others. Different methodological approaches can consider the same issue from different perspectives and hence consistency across datasets speaks to the strength of a particular finding. Similarly divergences can highlight particular complexities and important areas of uncertainty (Bryman, 2006).

Although the analysis was in many respects novel, it was grounded in well-established techniques arising from mixed method research. The approach involved the development of an 'integrative logic' through a form of thematic analysis (Mason, 2002). Insights from both phases were combined to generate a wide-ranging set of meta-themes that connected preferences with the underlying concerns that explained them. Themes were then refined through an iterative process whereby we examined and re-examined data, and compared and dissected emergent themes via discussions amongst the research team. The resulting outcomes were the most important concerns that underlie both positive and negative views across multiple different aspects of change, which we characterise as public values. The analytic process ensured that values were never drawn from one data point but instead reflected careful and rigorous interpretation of the data as a whole (i.e. across survey preference questions, workshop transcripts, my2050 scenario responses in both phases, and open-ended survey responses).

3.3.2. Getting at values

The focus of this analysis was to examine values which underpin public preferences for energy system change. It is important to note that we did not map a specific value theory onto the data; the analysis was wholly data-driven with all values analytically derived from the combined data streams.

People reveal values both explicitly and implicitly (Kluckhohn, 1951) and there were two primary ways in which values were elicited. First, values were explicitly stated or evident in participant discussions and question responses, for example when explaining their positive or negative attitudes towards a technology or aspect of energy system change. For instance, participants explicitly talked about their aversion to 'waste' in multiple places in the data.

Second, values were derived through a more detailed interpretative process whereby underlying concerns were inferred from the expression of concerns about key issues (Satterfield, 2001). For example, the values associated with *social justice* were interpreted as underlying prevalent and deep concerns about the fair distribution of benefits and consequences related to particular choices.

Combinations of this interpretative approach and explicit statements were important in many cases for the constitution of values. For instance, views on energy security and demand side management were underpinned by concerns about *autonomy and power,* which at times were explicitly stated and at other times could be clearly inferred from reasoning about these aspects of change. The following provides a narrative account of the values that were derived from the data.

4. Findings and discussion

We outline 15 values grouped into six thematic clusters to comprise what we term a public value system for energy system change. The values represent ideals and principles that underpin normative visions for change; that is, they concern beliefs about how things *should* be not about how they are currently. The narrative for each value set starts with a statement about what the value cluster encompasses, which is then elaborated by providing illustrative examples from the research.

The narrative account is not exhaustive but aims to provide a balance between breadth (e.g. *where* the value is relevant for explaining people's preferences) and depth (e.g. *how* the value connects to evaluations of energy system change). Table 1 provides illustrative empirical data points which are indicative of the forms of data utilised to arrive at the specified values. However, it is not possible to show how the values emerge at every point in the data in a paper of this length, and it is also important to acknowledge that each given example will never speak fully to a specific value (for a full presentation of the data please see three reports that have been published separately—Parkhill et al., 2013). The value clusters are interlinked and overlapping. The categorisations that are presented were derived through the analysis and offer the best descriptors overall for the most prevalent concerns.

4.1. Public values for energy system change

The first value cluster is called ***Efficient and Not Wasteful***. This cluster aligns with an energy system that does not involve wasting or producing waste products, and which is efficient in a broad sense. The values in this cluster were derived from explicit preferences for efficiency in many parts of the system, negative attitudes towards waste both in terms of products and processes, and positive views on the reuse of waste products (for illustrative data points see Table 1).

Efficiency as a concept emerges frequently within public responses to questions about energy system change. In general, efficiency is viewed as achieving the same thing with less, or putting the same amount in but getting more out. Being more efficient is often linked to perceptions of improvement, where increased efficiency is seen as a sign of progress.

In contrast, wasting or producing waste is seen as inherently negative and something to be avoided. A core example of where concern about waste underpins public preferences relates to reducing energy use, but negative perceptions of 'wasting' also extend beyond 'energy' (e.g. wasting food, time, opportunities). This is strongly linked to the perception that energy is currently wasted in many respects; common examples given by our participants include stand-by functions, and energy use in public and commercial buildings. Concerns around wasting energy are particularly heightened in the context of wasting something that is perceived as finite, most obviously fossil fuels.

[1] The scenario narratives (fully detailed in Butler et al., 2013) were developed from a range of scenario sources (e.g. DECC, 2010; UKERC, 2011; WWF, 2011 WWF, 2011) and from information attained through interviews with expert sources. They were designed to reflect three plausible future energy system scenarios. 1. A "business as usual" scenario depicting continuing reliance on fossil fuels along with associated impacts relating to climate change and energy security. 2. A highly technological response to energy issues depicting use of technologies like carbon capture and storage and nuclear energy along with some renewable energy deployment and a small amount of change on the demand side. 3. A scenario centred on high levels of renewable deployment and correspondingly higher levels of change to the demand side.

Table 1
Illustrative data points for each of the six identified social value clusters, and broader public vision for energy system change. Any single data point may relate to more than one value cluster.

VALUE CLUSTER Description	Values	Illustrative data points (qualitative and quantitative)
EFFICIENT AND NOT WASTEFUL		*"If you walk around a major city at night the buildings are ablaze…there's nobody in them but they're all lit and up that's a waste of energy. The London Eye is very pretty lit up but there's no reason to be lit up for that long."* 1/3 of the 73% of respondents that agreed Britain needs to reduce the amount of energy it uses thought that a lot of energy is currently being 'wasted', 'used unnecessarily' and 'taken for granted'.
A system that does not involve wasting and/or produces waste products and that is efficient. A system that does not waste opportunities arising from energy system change, and capitalises on the resources and capacities of the UK.	**Avoiding Waste**	*"We create waste and it has to be got rid of and you just can't keep burying it so you have to do something with it*." *"If it is recycled I have no problem with it [biofuel], but if it is a crop that's specifically grown for fuel then no, not when you've got starving Ethiopia or wherever else."* [also see Just and Fair, Process and Change]
	Efficiency	Over 80% of respondents included high levels of efficiency improvements for homes and business in their 2050 energy scenarios submitted as part of the survey.
	Capturing opportunities	*"Why aren't we investing in it? [electric cars] We should be world leaders in it."* *"That's a new source of jobs* [developing tidal energy]*– we have no jobs to give anybody – it's work….that is our future, isn't it. So if that is our future and it's going to be clean, safe and create jobs – because then you'll have all your engineers, you've got the builders and things…"* [also see Environment and Nature, Secure and Stable]
ENVIRONMENT AND NATURE		79% of respondents believe the UK should reduce its use of fossil fuels. When asked why, respondents most often mentioned the unsustainable nature of fossil fuels ('finite/running out'; 48%) and environmental harm (including climate change; 36%) as reasons for holding this viewpoint. 88% of respondents perceive wind energy to be a clean source of electricity.
A system that uses and produces energy in an environmentally conscious way and does not unnecessarily interfere with, or harm, nature.	**Environmental protection**	*"[renewable energy]…nobody's getting hurt. The planet's not getting hurt. You're using something that is natural."*
	Nature and naturalness	*"…coal and oil is natural but the wind keeps coming and coming… it will always keep giving us wind."*
SECURITY AND STABILTY		*"…the thing I would be more concerned with would be the electricity becoming unaffordable because we rely on it a lot and of course [other participant] was saying that it is going to be a bit frightening for the younger generation"* [also see Just and Fair]
A system that ensures access to energy services both in terms of availability and affordability. A system that is reliable and safe both in the production and delivery of energy services.	**Availability and affordability**	83% of respondents are fairly or very concerned that in the next 10-20 years electricity and gas will become unaffordable for them. 78% of respondents are concerned that petrol will become unaffordable for them.
	Reliability	*"[About using public transport] I live in the middle of nowhere so I have to have a car. I work in various places; I couldn't get to any of them without my own transport."* [also see Just and Fair] *"We looked at all sorts of things, we looked at ground pumps…and all these wonderful systems and we asked about 9 heating engineers around and…basically you couldn't find anyone to do anything at all so…we ended up with the bog-standard combi-boiler."*
	Safety	52% of respondents agree that nuclear power is a hazard to human health; and only 26% believe it is safe. In contrast, 81% of respondents agree that wind energy is safe, and only 5% believe it to be a hazard to human health.
SOCIAL JUSTICE AND FAIRNESS		54% of respondents think the national government should be mainly responsible for ensuring that appropriate changes are made to the UK energy system over the next 40 years. Responsibility was also subscribed to energy companies (16%) and individuals (13%). These findings should be interpreted in light of the findings from the qualitative workshops:
A system that is developed in ways which are mindful of implications for people's abilities to live healthy lives. A system that is fair and inclusive and where all actors are honest and transparent about their actions.	**Social justice**	*"Part of the problem is that they have opened up the market place and the market place now dictates what we pay whereas before it was centralised and government-led and a fair price for all, now we swap and the next week they put their prices up and you wish you stayed with that one."*
	Fairness, honesty, and transparency	*"I think it does need to be uniform because at the minute we are playing in a monopoly and we are losing because they are getting mega big bucks from the profits."* [also see Autonomy and Power] *"I generally worry about the price because the way things are going, is like you know you wake up the following day and the energy company will just tell me that there will be an increase in price, and there is nothing you can do about* it." *"Electricity companies obviously…have some ownership of it as they have had so many years of profit making and offering us gas and electric, definitely they have to take some responsibility."*
AUTONOMY AND POWER		82% of participants are very of fairly concerned about the UK becoming too dependent on energy from other countries.
A system that is developed in ways that do not overly threaten autonomy, infringe upon freedoms, or significantly compromise abilities to control personal aspects of life.	**Autonomy and freedom**	78% of respondents found appliances such as digital boxes, TVs and computers automatically turning off if they are left on standby for a considerable amount of time acceptable. 47% found the following scenario acceptable: Your shower turning off after a set period of time. However, only 30% found a scenario acceptable in which fridge or fridge-freezers would be switched off by an electricity network operator for short periods of time (provided the temperature of the fridge/freezer remains within a certain specified range).
	Choice and control	*"I'd quite object if somebody else had that control…I find that a bit draconian actually…It's a bit like George Orwell, that… 'It has decreed you must have' – that really annoys me."*
PROCESS AND CHANGE		*"Well, all the installation of the electric and solar panels, the bio fields, it is not going to happen overnight, all of this is gradually going to come into our lives, but it is a really good vision."*
A system that is developed with a focus on the long-term trajectories being created; that takes into account system interconnections and interdependencies; and represents improvement both in terms of socio-technological advances and quality of life.	**Long-term trajectories**	*"We are using these short term resources so it [CCS] feels like it is a short term solution, maybe just cleaning up as opposed to let's look at this again and let's look to the future longer term even beyond 2050."*
	Interconnected	*"I feel uneasy about it [growing energy crops]…We have a growing population, we haven't got a dying population in the world, people have to live somewhere so that means land is taken up with housing, industries, transport systems, so do we then start buying pieces of land or going to war because we need Africa's bit of land…?"*
	Improvement and quality	"*Things should be invented and improved."* *"I think it's [stopping flying] a backwards step and I know that's really controversial and stuff but I think for me you know living and exploring and pushing boundaries is something that's really important to what makes us who we are."*
Core preferences/Public vision for energy system change		Illustrative data points (qualitative and quantitative)
REDUCED ENERGY USE OVERALL AND REDUCED USE OF FINITE RESOURCES **A system that reduces overall energy usage while simultaneously reducing the use of finite resources (as compared to the current state).**		73% of respondents agree that Britain should reduce the amount of energy it uses. 79% believe the UK should reduce its use of fossil fuels. When creating their own 2050 energy future scenarios, on average, respondents did not make more changes to one side of the energy system over another (demand vs. supply side). *"Just because I know that, it just makes me feel a bit safer knowing that it [renewable energy] is always going to be there, whereas when you hear the people, you know, with the doomsday theory that it's [fossil fuels] going to run out and we have nothing left, that would be a worry in the back of my head, because I know that I'll have to deal with it at some point, and I know that my kids will definitely have to deal with it."* [also see Just and Fair, Environment and Nature]

The notion of wasting resources extended to renewable resources that are perceived as naturally abundant in the UK, such as marine energy or wind. This concern is also linked to positive views on the need to maximise opportunities in relation to job and industry creation and develop technologies associated with these abundant resources (e.g. leading marine energy developments globally; Table 1).

Furthermore, the idea of *producing* waste is seen as problematic, primarily because of the consequences, such as ongoing health and environmental hazards, and requirements for continuous management. To illustrate, this concern underpinned negative views of nuclear energy and carbon emission storage (i.e. in CCS proposals). In contrast, publics have positive views towards the reuse of waste products, for example, biomass from waste products (e.g. food waste) is viewed more favourably than grown-for-purpose energy crops.

Within this first value cluster we can already note that these values connect to individual elements of system change in both positive and negative ways. Connections between values start to become apparent because more than one value informs responses to a specific aspect of change. For example, producing waste is seen as inherently negative, in part, because it is associated with negative impacts for the environment and human health. This relates to the second value cluster, ***Environment and Nature***.

Core to this cluster is the ideal that the energy system should avoid producing pollutants and should not contribute to, or at the very least avoid detracting from, the general healthiness and wellbeing of society. Overall, the values in this cluster were derived from negative perceptions of environmental harm underpinning preferences for and against multiple energy system technologies and processes. These include both general environmental harm, e.g. by contribution to climate change and pollution, and more specific concerns around possible contamination (e.g. oil spills, radioactive waste leakages, disposal of toxins) (for illustrative data points see Table 1). It is within this cluster that concerns about climate change manifest in public perspectives towards energy system change. However, climate change represents just one issue within a more general concern about environmental degradation. In this sense, concerns about environmental protection also go beyond nature and wildlife, to encompass issues regarding *the relationship* between nature and society.

To illustrate, this value cluster underpins a common comparison between negative perceptions of fossil fuels and positive perceptions of renewable energy technologies. Whereas renewable energy is seen as clean and as having limited waste by-products; fossil fuels are widely perceived as dirty as well as environmentally and socially damaging. Similarly, renewables are seen as part of a natural process tapping into an infinite resource that is not significantly altered by society's use of it (e.g. the wind will keep blowing whether or not a wind turbine harnesses it to produce electricity, Table 1), whereas fossil fuels are seen as artificial and intrusive with regards to the necessary manufacturing processes to make use of them (e.g. raw resource extraction and combustion).

Whilst we would argue that participants understood that the formation of fossil fuels were the result of natural processes, the timescales in which they form mean that it does not hold the same sense of being an infinite resource as renewable energy. We further argue that these considerations also, in part, explain why biomass or biofuels are not seen as renewable in the same way as other renewable technologies; i.e. because there appears to be a more significant potential for them to be mismanaged, depleted, and ultimately cause harm to the environment and society.

This last point concerning the safety and well-being of the environment leads on to the third set of values identified within our datasets; ***Security and Stability***. Core to this cluster is the ideal that the energy system should ensure access to energy services for all members of society, and that it should produce and deliver those energy services in a reliable and safe way. The values in this cluster were primarily derived from expressed concerns around the safety of different technologies, discussions about the risks posed by transition processes for different groups of people, and the recognition that energy needs to be accessible and reliable for society to function properly (for illustrative data points see Table 1).

To elaborate, the desirability of 'safe' systems related to concerns about those involved in working within the energy system (e.g. workers at a power station) and those living in close vicinity to any infrastructure (e.g. power stations or pylons). We found greater acceptance of events with limited local negative impacts (e.g. a wind turbine breaking down) than those more significant negative events that have a lower probability of occurring (e.g. a nuclear accident). This is suggestive of the importance participants placed on the *consequences* of safety lapses when evaluating energy systems.

Considerations of security and stability also manifest in views on how the energy system should be developed. Underpinning several preferences was the concern that implementing change should not put people or businesses at risk of negative impacts whether they are financial, social, cultural or material. Consequently, where risk is inherent in proposed changes, publics held expectations for measures to be taken to mitigate them. One example of such measures from the data was providing an extended warranty for early adopters of fully electric vehicles.

The security and stability cluster also encompasses concern about the reliability and dependability of the energy system, meaning that efforts should be undertaken to minimise the impact of shocks and address stresses (e.g. resource scarcity, service interruptions and/or cost fluctuations). This is important to people because of the detrimental effects associated with interruptions to services, both in terms of personal effects (e.g. not being able to heat the home) and national effects (e.g. negative effects on the economy). This desire arises out of recognition that energy is integral to all parts of our society and when a shock or stress manifests it poses a threat to every aspect of life. We would argue that there is an underlying expectation that energy needs will always be met in a well-functioning society. Indeed, a core aspect of this value cluster concerns the accessibility of energy services, both in terms of the availability of energy to support services and people's personal ability to afford them (Table 1). With regards to perceptions of affordability, though we find that the notion of cheap energy is desirable, the core concern relates to energy being affordable relative to income levels. In this regard, our data suggest that energy is perceived as a basic need and people therefore see the provision of governmental support as important to ensure energy is available and accessible for all.

This set of values also encompasses concern about the accessibility of proposed energy system changes in other ways. For example, those who wish to implement an energy intervention such as insulation, solar panels, or new heating systems, should be supported to do so. Here, support refers not only to affordability and access to investment capital, but also factors such as the availability of skills and infrastructures (e.g. accredited suppliers and maintenance providers; see Table 1). The idea of supporting changes by making them accessible is further related to the notion that elements of transition should not be imposed on people. Rather, people should be supported to enact changes that best suit their contexts. To illustrate this, participants expressed the view that it would be inappropriate to apply the same penalties to rural as to urban dwellers for using personal transport (Table 1).

Issues of security and stability within energy system change also relate to the value cluster of ***Social justice and Fairness***. This

cluster pertains centrally to a concern that the energy system is developed in ways which are mindful of implications for people's abilities to live healthy lives (see Schlosberg, 2004), and is fair and inclusive where all actors are honest and transparent about their actions. Values in this cluster were derived particularly from publics referring to the fair distribution of risks and benefits for different groups of people (e.g. cost, ability to make a living), how these are managed within energy system transitions, and how such responsibilities are distributed (for illustrative data points see Table 1).

To elaborate, evident within the data are concerns related to the perceived differential impacts of alternative energy system options for both people and environment. For example, concerns were evident in relation to costs (i.e. social, environmental, financial impacts) of energy systems disproportionately affecting those that were vulnerable or structurally disadvantaged in other ways (e.g. the fuel poor). We find that such concerns related not only to people now and in Britain but also to those in distant locales (e.g. people living in countries where food shortages might be created or exacerbated through biofuel production, Table 1) and in different times (e.g. future generations), bringing to mind issues of intra- and inter-generational justice (for discussion see Schlosberg, 2004; Barry, 1997). One instance of this relates to public perceptions of particular forms of energy as holding potential to generate global conflicts. Based on our interpretations, this concern in part underlies preferences for reductions in use of fossil fuels and people's ambivalence about bioenergy. A further example relates to issues participants identified in the distribution of infrastructure affecting some people more negatively than others and how these differential effects can be amplified over time, i.e. energy facilities disproportionately affecting particular locales and giving rise to repeated and residual injustices (Mohai et al., 2009).

Within our data, we also find social justice concerns connected to questions about who might get left behind as particular technologies, skills sets, and so forth, become obsolete. Here the justice issues are related to the same core concern about the impacts on people's ability to live healthy lives but refer to energy system elements that are anticipated to be far less significant in the future (e.g. coal). It encompasses a view that transition processes should be undertaken in such a way as to ensure people are able to adapt to changing living contexts and given proper consideration through, for example, support in developing alternative livelihoods (e.g. retraining for new jobs).

Values around justice and fairness also connect to public views on specific actors within energy system change (Table 1). We find a core belief that institutions related to energy systems should be honest, open and committed to principles of fairness. Concerns with transparency also arise from the notion that if there is nothing untoward happening, there should be nothing to hide. Within our data, this forms a basis for negative perceptions of the seemingly opaque operations of energy companies and governments in existing energy systems (e.g. our participants perceived reasons for price increases as unclear and energy bills as misleading). Furthermore, these concerns are linked to preferences with regards to affordability and the mechanisms for financing transitions. In particular, there was a view that the distribution of energy system costs should be fair. For example, those actors that have benefitted financially from existing systems should have greater responsibility for the financing of low carbon transitions, rather than costs being passed on to consumers. These values also underpin public perceptions about energy company profits which were seen as unfair in a context where people were experiencing fuel poverty and where companies were able to monopolise and limit consumer choice. Overall, current market arrangements in the UK were perceived as not benefitting consumers in the ways that they should. We would therefore argue that publics have strong concerns about what is essentially the vertical integration of wholesale and retail, and the liberalisation of energy markets because these are not seen to ensure the attainment of a just and fair energy system.

These concerns further relate to the value cluster ***Autonomy and Power***. This cluster highlights public concerns about the need to ensure that changes being undertaken do not threaten autonomy or significantly compromise personal control and freedom. The values here are derived from prevalent concerns about freedom of choice and maintaining autonomy both at the national and personal scale (see Table 1 for illustrative data points).

To elaborate, there was a desire evident from the research that no single institution, group or actor should become so powerful that they can monopolise the energy system and manipulate it to their own advantage (Table 1). This finding is, in part, reflected in negative views about the domination of large energy companies in the current UK system, leading to the perceived unfair distribution of cost and benefits. These concerns about Autonomy and Power further manifest in connection with changes that relate to domestic demand-side management (DSM). Within our data, we find public support for being enabled to shift personal demand (e.g. through advice and information) but more negative and conditional views with regards to changes and technologies which are perceived as imposed or externally controlled (e.g. remote control by a third party; see Table 1 and Spence et al., 2015).

We would further argue that these values, in part, explain favourable views towards micro-generation technologies. For example, one reason why solar PV or wood-burning fires were viewed positively was because they were seen to afford a form of self-sufficiency and autonomy. Though our findings have generally focused on centralised energy systems, from the values attached to micro-generation technologies we can infer that aspects of decentralised energy systems may be seen as (highly) desirable, at least to the extent that they align with these values—i.e. affording self-sufficiency and security, being seen as facilitating greater distribution of benefits.

Concerns about both autonomy and control are also evident at national levels. For instance, negative public views about national dependency on energy imports are, in part, underpinned by concerns about autonomy. This does not necessarily mean, however, that publics think the energy system should only be reliant on domestic resources, as they recognise the UK energy system is part of a global network.

The final cluster of values emergent from our synthesis analysis pertains to views on ***Process and Change*** inherent to energy system transitions. This value cluster encompasses concerns underpinning views on how transition processes should occur. Core to this cluster is the ideal that the energy system should be developed with a focus on the long-term trajectories being created, and enabling improvement both in terms of socio-technological advances and quality of life. These values are particularly evident in ambivalent views around some supply technologies (e.g. biofuels and CCS), negative reactions to the suggestion of certain lifestyle changes (e.g. reducing meat consumption, flying less), and references to the difficulty inherent in making long-term changes to system elements, like heating and transport provision (see Table 1 for illustrative data points).

To elaborate, we found that public preferences towards various technologies or proposed changes are conditional on the way they might interconnect with other aspects of energy system change and wider social and economic life. This underlies some of the issues people raise in relation to biofuels, e.g. that they will interfere with food supplies if not developed with an understanding of system implications and dependencies (Table 1). This further connects to a concern that the possible implications of changes,

beyond energy systems *per se*, should be integral to decision-making (e.g. economic, food and water systems).

Interactions between energy system changes and cultural systems are also embedded in this value cluster. Underlying several different preferences is a basic concern that changes should not reduce people's quality of life, which includes notions around comfort, convenience, and control amongst other things (see Shove, 2003). Concerns about some proposed changes emerge because they are seen to threaten aspects of quality of life. We suggest that this underpins and helps to explain the strong reactions that we found to ideas of eating less meat and flying less for leisure purposes, since these represented threats to core cultural aspects of UK life—e.g. social interaction, enjoyment, pleasure, relaxation, "experience" (Table 1). We further suggest that other changes perceived to pose threats to quality of life and challenge cultural values in some way are likely to meet with similar strong resistance.

The value placed on improvement also relates to technological development, particularly around efficiency as an important goal, but also to wider impacts and implications of energy system change in terms of well-being. As such, it connects with the public view that transitions should be motivated by more than profit-making, and should instead ensure wider social goals are kept integral to change processes. This is rooted in the idea that we should address problems in ways that represent the beginnings of new trajectories, rather than simply treating symptoms. This aspiration underpinned some of the concerns that CCS and biofuels raised for our participants, as these did not represent a transition towards a long term desirable trajectory (Table 1), e.g. from finite to renewable resources. Based on these observations we argue that these technologies were perceived as a "non-transition"—not representative of real change, or new trajectories (Butler et al., 2013).

In relation to this, we therefore argue that longer-term process based conceptions of change, rather than time-limited ones, underpinned public views on multiple aspects of system change. Public perspectives, as they emerged in our data, generally did not focus on specific end-points (e.g. 2050, 2100) but instead changes were envisaged to emerge over time (Table 1). One example of this is in relation to heat transitions. We found that proposed transitions away from gas central heating were perceived as requiring greater embedding in societal and consumer options *now* to allow for gradual transformations. This was as opposed to denoting time points (i.e. 2025) where transitions to new forms of heat will begin. This is a subtle but important element of public views on change processes; i.e. the perception that change occurs slowly and involves initiating new trajectories that will unfold over long time periods.

Finally, we summarise our account of public perspectives on energy system change with two consistent and strong preferences that were evident throughout the data set (Table 1 'core preferences'). These provide further indication of the type of long-term trajectory publics envisage: on the supply-side this is characterised by a *strong commitment to renewable forms* of energy production and a *corresponding shift away from fossil fuels.* On the demand-side it relates to an overall *improvement in energy efficiency and reductions in energy demand* through the development of technology and infrastructures (e.g. public transport, demand management, electric vehicle charging points) to support changes in lifestyles. Based on our data this comprises the public vision for energy system change.

5. Concluding discussion

We have interrogated an extensive and in-depth set of data on British publics' preferences with regards to current and future energy system change. Through this analysis we have identified a set of social values that enable us to understand and explain preferences for different energy system configurations, elements and technologies. We have asserted that the identified values provide an indication of the shared cultural ideals that people draw on and bring to bear when engaging with notions of energy system change.

Examining the values that underpin people's responses is a relatively novel way of conceptualising public perspectives on energy system change. From the analysis, three important points emerge. First, we propose that the interconnected nature of public values, and as such the set of values in combination, will provide most meaningful insight in terms of public perspectives on energy system change. It is the *set* of values as a whole that is important in understanding how public responses can emerge depending on the particular context. We aim to show that these values are not discrete entities but are connected to each other in multiple ways (e.g. increased 'efficiency' is a sign of 'improvement'), that specific responses are informed by multiple values, and that each value underpins and informs views on numerous different aspects of energy system change (e.g. autonomy and power values connect to views on DSM, operations of energy companies etc.)

Second, it is evident that public concerns are not only connected to technological and ecological aspects of the energy system but also to those that can be characterised as being more social or cultural. These include, for example, threats to finances or personal identity, concerns over lack of pace, scope and direction of change, or power relations between different actors, and issues of (dis)trust and mistrust. In this regard, *how* change is achieved is just as, if not more, important than *what* is done. Similarly, public perspectives on energy system transitions quite clearly connect with wider social ideas and experiences that are not directly about energy *per se* but pertain to broader concerns about the kinds of societies in which we live.

Third, publics place high importance on considering overall changes and trajectories with regards to energy system change, rather than short-term solutions. As such, it seems that the trajectory we are perceived to be on is paramount in informing public acceptability more generally, and that specific preferences or responses might play out depending on whether publics see it fitting in with a desirable long-term vision. From this we propose that public acceptability in the short- or medium-term is likely to be contingent on evidence of long-term trajectories towards a broader vision of a sustainable future underpinned by the outlined value set.

Ultimately we argue that meaningful public acceptability arises from the connections and associations between these broader concerns (values) and specific elements of energy system change. For example, from our data we know that there is a strong public acceptability of solar energy. We also know that this preference exists because solar energy is usually perceived as 'renewable' 'fair', 'just' and 'clean'. Accordingly, we would predict that if a solar power development supplying the UK but residing in North Africa was revealed as causing local environmental contamination and land-use territorial disputes, it would likely no longer be acceptable to people because the associations between some of these values and the technology will be severed. In this instance it would still be considered 'renewable' but no longer perceived as 'fair', 'just' or 'clean'. We therefore propose that public preferences are based on the inclusion of renewable, clean, fair and just elements in future energy systems, not solar energy technology *per se*.

Therefore, this approach to understanding public perspectives also provides some explanatory power as to how public views might change in the future, as the energy system changes and takes shape, and as new issues emerge. This argument is premised on the

notion that because existing values and experiences are important in helping people make sense of new encounters, we can anticipate their reactions to new energy developments (Macnaghten, 2010). For example, from our research, we would anticipate that shale gas does not address the overarching concerns that publics have raised particularly because it represents a continuation of fossil fuel regimes, which are associated with negative impacts on the environment and human health, and unfair outcomes in terms of the distribution of costs and benefits (also see Boudet et al., 2014).

We therefore suggest that the acceptability of any particular aspect of energy system transformations will, in part, be conditional, upon how well it fits into, or strives to be consistent with, the social value system described. Publics are unlikely to settle for a form of change that does not show signs of commitment to the longer-term trajectories commensurate with these values.

5.1. Implications for conceptualising public acceptability

The values we have set out may appear idealistic and it is important to highlight that they relate to how people think the world *should* be, rather than worldviews or perceptions of how things currently are (Kearney, 1984). Of course values interconnect with people's experiences and social commitments (e.g. their relationships with others, their form of work). In this way, preferences for particular long-term trajectories are continually negotiated in terms of people's everyday experiences. Naturally, we find tensions between values and worldviews within our data as well; for example people can express a desire to reduce fossil fuels yet also prefer the use of conventional cars over public transport. However, rather than only focusing on identifying seemingly contradictory beliefs, we argue for a focus on what underpins these. For example, a preference for owning a vehicle rather than rely on public transport is often associated with comfort, control, convenience, and lower cost (e.g. cars being experienced as more private and clean, public transport being perceived as infrequent and relatively expensive). This way of conceptualising public acceptability provides a basis for understanding public perspectives in a more meaningful way, i.e. how to achieve broad and sustained societal acceptance for energy transitions.

Similar we would advise against conceptualising public acceptability (or energy system change more widely) too narrowly in terms of simple trade-offs between potentially competing values (e.g. calls for regulation vs. freedom of choice). Such trading-off implies that as long as one side of the issue under scrutiny is addressed, the others will no longer matter; one will be traded off against the more important other. To illustrate, this implies that if concerns about cost and affordability are greater than climate change and energy security, then as long as cost is addressed the other issues can be ignored or traded off against achieving this aim. We argue that public acceptability does not work in this way and is unlikely to be achieved if such an approach is taken (e.g. in policy and communication around energy transitions). While aspects of preference formation are clearly sensitive to both the contexts of transition, and the conditionality of options on other things being realised, simply changing the framing or salience of isolated attributes of technologies is unlikely to achieve wider societal acceptance. For example, public acceptability of fossil fuel power generation, or of shale gas development, is unlikely to be changed markedly by simply emphasising short-term cost savings, or energy security dimensions, if the wider set of concerns that publics have with unsustainable transitions remain largely unaddressed.

Instead, we argue that given the stability and longevity of social values, each identified value cluster is likely to have lasting relevance at the societal level and it is unlikely that any of these will ever be completely disregarded (or completely traded-off against another value). It is important to note that the analysis is aimed at understanding public perspectives more broadly (e.g. to provide ways of including these in policy decisions), and we do not make claims about the kinds of negotiations an individual might engage in to determine their preference about a specific component of system change in a given context. Of course individuals, or groups of individuals, might subscribe less to a particular subset of the value system compared to another group. However we would assert that the value set as a whole needs to be considered in order to achieve meaningful public acceptability.

We would further argue that something closer to compromise might better characterise the difficulty that 'trade-offs' invoke, i.e. that ideal scenarios are not possible and some things will have to be accepted in pursuit of transitions that may not be wholly desirable (cf. reluctant acceptance of nuclear power: Pidgeon et al., 2008). That is to say, publics are not expecting the ideal *per se* but evidence that efforts are being made to strive for this are likely to be important in acceptance of approaches and changes that are not commensurate with the values. In line with our earlier point, publics are unlikely to compromise on some of the core ideals for the long-term vision, but how this is achieved may provide room for compromise in the short-term. Critically, we propose that these short-term compromises are, in turn, likely to be conditional on a longer-term commitment to more sustainable trajectories underpinned by the identified value set.

For example, in our research we find that CCS does not fit well within energy transitions envisaged by publics (e.g. although CCS reduces carbon emissions it does not address other concerns around the use of fossil fuels). Nonetheless we would argue that the use of CCS by certain industries may be acceptable to publics (because these industries will find it more difficult to change in the short-term) as long as a there is a simultaneous and significant commitment to renewable technologies elsewhere in the system (also see Butler et al., 2013). This reasserts the need for energy transformations to follow a long-term trajectory that is congruent with the value_system described. This point is also critical for understanding public responses to elements of system change that do not, in an obvious way, align with the values. We suggest that these elements can still be implemented in ways that are *more or less* commensurate with the values. For example, certain aspects of demand-side management will be more acceptable to people if they allow some form of autonomy (e.g. through override functions), compared to developments that focus exclusively on remote interference. In this way the values present a normative vision for change that can provide the basis for developing policies that are genuinely responsive to citizens' values.

How compromises are negotiated and agreed upon is of course a complex issue in itself, and is unlikely to be an easy process. However, understanding public perspectives in this way is an important first step towards including social dimensions within decision making around such a complex national policy issue (also see Butler et al., 2015; Pidgeon et al., 2014).

To conclude, we advocate the consideration of public perspectives beyond single elements of system change, and argue for the relevance of examining the social values that underpin public responses in addition to specific preferences. We assert that this would provide a basis for more robust inclusion of public and social perspectives in policy and scenario-building in relation to energy futures. The identified value system provides a strong basis for anticipating and understanding likely public responses and should be considered alongside other more technical elements of system change (also see Miller et al., 2013). Although this would not guarantee the absence of contestation, a more sophisticated understanding of public perspectives is clearly desirable if we are to successfully develop transitions to alternative energy futures.

Acknowledgements

This research formed part of the programme of the UK Energy Research Centre and was supported by the UK Research Councils under the Natural Environment Research Council award NE/G007748/1 (grant NE/I006753/1). Additional support was received from the Welsh Government, the Leverhulme Trust (F/00 407/AG), the US National Science Foundation (cooperative agreement SES 0938009), and for Alexa Spence from Horizon Digital Economy Research, RCUK grant (EP/G065802/1). The research team would also like to thank the project advisory panel for their valuable input.

References

Adger, W.N., Barnett, J., Brown, K., Marshall, N., O'Brien, K, 2013. Cultural dimensions of climate change impacts and adaptation. Nat. Clim. Change 3, 112–117.
Barry, B., 1997. Sustainability and intergenerational justice. Theoria 89, 43–64.
Bickerstaff, K., Lorenzoni, I., Pidgeon, N.F., Poortinga, W., Simmons, P., 2008. Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste. Public Underst. Sci. 17 (2), 145–169.
Boudet, H., Clarke, C., Bugden, D., Maibach, E., Roser-Renouf, C., Leiserowitz, A., 2014. Fracking controversy and communication. Energy Policy 65, 57–67.
Brown, T.C., 1984. The concept of value in resource allocation. Land Econ. 60 (3), 231–246.
Bryman, A., 2006. Integrating quantitative and qualitative research: how is it done? Qual. Res. 6 (1), 97–113.
Bulkeley, H., Castan Broto, V., Hodson, N., Marvin, S., 2013. Cities and Low Carbon Transitions. Routledge, Oxon.
Butler, C., Demski, C., 2013. Valuing public engagement with energy system transitions: the importance of what lies beneath. Carbon Manag. 4 (6), 659–662.
Butler, C., Parkhill, K.A., Pidgeon, N., 2013. Deliberating Energy Transitions in the UK—Transforming the UK Energy System: Public Values, Attitudes and Acceptability. UKERC, London.
Butler, C., Demski, C., Parkhill, K., Pidgeon, N., Spence, A., 2015. Public values for energy futures: framing, indeterminacy and policy making. Energy Policy doi: http://dx.doi.org/10.1016/j.enpol.2015.01.035.
Chan, K.M.A., Satterfield, T., Goldstein, J., 2012. Rethinking ecosystem services to better address and navigate cultural values. Ecol. Econ. 74, 8–18.
Corner, A.J., Markowitz, E., Pidgeon, N.F., 2014. Public engagement with climate change: the role of human values. Wiley Interdiscip. Rev. Clim. Change 5, 411–422.
Crompton, T., 2011. Values matter. Nat. Clim. Change 1, 276–277.
Curran, G., 2012. Contested energy futures: shaping renewable energy narratives in Australia. Glob. Environ. Change 22, 236–244.
De Best-Waldhober, M., Daamen, D., Ramirez, A.R., Faaij, A., Hendriks, C., de Visser, E., 2009. Informed public opinions on CCS in comparison to other mitigation options. Energy Procedia 1, 4795–4802.
DECC, 2010. 2050 Pathway Analysis. UK Department of Energy and Climate Change, London.
DECC, 2011. The Carbon Plan. UK Department of Energy and Climate Change, London.
Demski, C., Spence, A., Pidgeon, N., 2013. Summary Findings of a Survey Conducted in August 2012—Transforming the UK Energy System: Public Values, Attitudes and Acceptability. UKERC, London.
Dietz, T., 2013. Bringing values and deliberation to science communication. Proc. Natl. Acad. Sci. 110 (Suppl. 3), 14081–14087.
Dillman, D.A., 2007. Mail and Internet Surveys: The Tailored Design Method. John Wiley, UK.
Douglas, M., 1992. Risk and Blame. Routledge, New York.
Douglas, M., Wildavsky, A., 1982. Risk and Culture: An Essay on the Selection of Technological and Environmental Dangers. University of California Press, Berkeley.
Einseidel, E.F., Boyd, A.D., Medlock, J., Ashworth, P., 2013. Assessing socio-technical mindsets: public deliberation on carbon capture and storage in the context of energy sources and climate change. Energy Policy 53, 149–158.
Ekins, P., Keppo, I., Skea, J., Strachan, N., Usher, W., Anandarajah, G., 2013. The UK Energy System in 2050: Comparing Low Carbon, Resilient Scenarios. UKERC, London.
Fischer, F., 1999. Technological deliberation in a democratic society: the case for participatory inquiry. Sci. Public Policy 26 (5), 294–302.
Fischhoff, B., 1993. Value elicitation: is there anything in there? In: Hechter, M., Nadel, L., Michod, R.E. (Eds.), The Origin of Values. Walter de Gruyter, New York.
Fleishman, L., Bruine de Bruin, W., Morgan, M.G., 2010. Informed public preferences for electricity portfolios with CCS and other low-carbon technologies. Risk Anal. 30 (9), 1399–1410.
Hards, S., 2011. Social Practice and the evolution of personal environmental values. Environ. Values 20, 23–42.
Hechter, M., 1993. Values research in the social and behavioural sciences. In: Hechter, M., Nadel, L., Michod, R.E. (Eds.), The Origin of Values. Walter de Gruyter, New York.
Hitlin, S., Piliavin, J.A., 2004. Values: reviving a dormant concept. Ann. Rev. Soc. Psychol. 30, 359–393.
IEA, 2013. International Energy Agency Annual Report: World Energy Outlook 2013. www.iea.org/publications/freepublications/publication/international-energy-agency-2013-annual-report.html (accessed 15.07.14.).
Jasanoff, S., 2003. Technologies of humility: citizen participation in governing science. Minerva 41, 223–244.
Jasanoff, S., Kim, S., 2013. Socio-technical imaginaries and national energy policies. Sci. Cult. 22 (2), 189–196.
Jasanoff, S., Wynne, B., 1998. Science and decision making. In: Rayner, S., Malone, E.L. (Eds.), Human Choice and Climate Change: The Societal Framework, vol. 1. Battelle Press, Ohio.
Kearney, M., 1984. World View. Chandler & Sharp Publishers, Inc., Novato, CA.
C, Kluckhohn, 1951. Values and value-orientations in the theory of action: an exploration in definition and classification. In: Parsons, T., Shils, E. (Eds.), Toward a General Theory of Action. Harvard University Press, Cambridge, MA.
Lichtenstein, S., Slovic, P., 2006. The Construction of Preference. Cambridge University Press, Cambridge.
Macnaghten, P., 2010. Researching technoscientific concerns in the making: narrative structures, public responses and emerging nanotechnologies. Environ. Plan. A 42, 23–37.
Maio, G.R., 2010. Mental Representations of Social Values. Zanna M.P. (Ed.), Advances in Experimental Social Psychology 42, 1–43.
Mason, J., 2002. Qualitative interviewing: asking, listening, interpreting. In: May, T. (Ed.), Qualitative Research in Action. Sage, London.
Miller, C., 2000. The dynamics of framing environmental values and policy: Four models of societal processes. Environ. Values 9, 211–233.
Miller, C.A., Iles, A., Jones, C.F., 2013. The social dimensions of energy transitions. Sci. Cult. 22 (2), 135–148.
Mohai, P., Pellow, D., Timmons-Roberts, J., 2009. Environmental Justice. Ann. Rev. Environ. Resour. 34, 405–430.
Moscovici, A., 1984. The phenomenon of social representations. In: Farr, R., Mascovici, S. (Eds.), Social Representations. Cambridge University Press, Cambridge.
National Grid, 2014. UK Future Energy Scenarios. http://www2.nationalgrid.com/uk/industry-information/future-of-energy/future-energy-scenarios/.
Parkhill, K.A., Demski, C.C., Butler, C., Spence, A., Pidgeon, N., 2013. Transforming the UK Energy System: Public Values, Attitudes and Acceptability—Synthesis Report. UKERC, London.
Pidgeon, N., Demski, C., Butler, C., Parkhill, K., Spence, A., 2014. Creating a national citizen engagement process for energy policy. Proc. Natl. Acad. Sci. 111 (Suppl. 4), 13606–13613.
Pidgeon, N.F., Hood, C., Jones, D., Turner, B., Gibson, R., 1992. Risk Perception. Ch 5 of Risk—Analysis, Perception and Management: Report of a Royal Society Study Group. The Royal Society, London, pp. 89–134.
Pidgeon, N.F., Lorenzoni, I., Poortinga, W., 2008. Climate change or nuclear power—no thanks! A quantitative study of public perceptions and risk framing in Britain. Glob. Environ. Change 18 (1), 69–85.
Reser, J.P., Bentrupperbäumer, J.M., 2005. What and where are environmental values? Assessing the impacts of current diversity of use of environmental and 'world heritage' values. J. Environ. Psychol. 25, 125–146.
Satterfield, T., 2001. In search of value literacy: suggestions for the elicitation of environmental values. Environ. Values 10 (3), 331–359.
Scheer, D., Konrad, W., Scheel, O., 2013. Public evaluation of electricity technologies and future low-carbon portfolios in Germany and the USA. Energy Sustain. Soc. 3 (8), 1–13.
Schlosberg, D., 2004. Reconceiving environmental justice: global movements and political theories. Environ. Politics 13 (3), 517–540.
Schwarz, S.H., 1992. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. In: Zanna, M.P. (Ed.), Advances in Experimental Social Psychology. Academic Press, Orlando.
Shove, E., 2003. Converging conventions of comfort, cleanliness and convenience. J. Consum. Pol. 26, 395–418.
Spence, A., Pidgeon, N., 2009. Psychology, climate change and sustainable behaviour. Environ. Sci. Pol. Sustain. Dev. 51 (6), 8–18.
Spence, A., Demski, C., Butler, C., Parkhill, K., Pidgeon, N.F., 2015. Public perceptions of demand-side management and a smarter energy future. Nat. Clim. Change 5, 550–554.
Strauss, A., Corbin, J., 1990. Basics of Qualitative Research: Grounded Theory, Procedures and Techniques. Sage, London.
Thevenot, L., 2001. In: Knorr-Cetina, K., Schatzki, T., Savigny Eike, V. (Eds.), The Practice Turn in Contemporary Theory. Routledge, London, pp. 56–73.
UK Data Service, 2006. Labour Force Survey Series. UK Data Service, Colchester, UK.
Walker, G., Cass, N., Burningham, K., Barnett, J., 2010. Renewable energy and sociotechnical change: imagined subjectivities of 'the public' and their implications. Environ. Plan. A 42, 931–947.
Whitmarsh, L., Upham, P., Poortinga, W., McLachlan, C., Darnton, A., Devine-Wright, P., Demski, C., Sherry-Brennan, F., 2011. Public Attitudes, Understanding, and Engagement in relation to Low-Carbon Energy: A Selective Review of Academic and Non-academic Literatures. Research Councils UK, London.
WWF, 2011. The Energy Report: 100% Renewable Energy by 2050. WWF, London.
Wynne, B., 1992. Misunderstood misunderstandings: social identity and public uptake of science. Public Underst. Sci. 1, 281–304.
Wynne, B., 1996. May the sheep safely graze? A reflexive view of the expert-lay knowledge divide. In: Lash, S., Szersynski, B., Wynne, B. (Eds.), Risk Environment and Modernity: Towards a New Ecology. Sage, London.